Individual and Relational Contributions to Parallel and Joint Attention in Infancy

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Abstract

Objective: This study examined the contributions of maternal bids for joint attention, relationship quality, and infant characteristics, to individual differences in infants' parallel and joint attention. **Method**: Fifty-two 10-month-olds and their mothers were assessed in order to investigate concurrent predictors of infant parallel attention, responding to joint attention, and initiating joint attention. **Results**: Parallel attention was predicted by infants' higher mental development, low expression of negative emotionality, and maternal entertaining behaviors. Responding to joint attention was marginally predicted by total maternal bids for joint attention. Initiating joint attention was predicted by the infants' low expression of negative emotionality, as well as marginally predicted by fewer maternal teaching behaviors. **Conclusion**: These results further the understanding of the factors influencing infant parallel as well as joint attention.

Keywords: parallel attention; joint attention; infancy

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In the final quarter of the first year of life, infants begin to participate in triadic interactions in which they share attention towards an object with another person (Bakeman & Adamson, 1984). Infants' ability to coordinate attention with a social partner has been argued to be important for the development of representational abilities such as language and play (e.g., Adamson, Bakeman, & Deckner, 2004; Carpenter, Nagell, & Tomasello, 1998; Delgado et al., 2002; McCune, 1995; Morales, Mundy, & Rojas, 1998). Indeed, problems in engaging in joint attention have been identified as an early marker for subsequent language and social-cognitive impairment in child populations at risk of developmental disorders such as autism (Dawson et al., 2004; Mundy & Neal, 2001; Sigman & Ruskin, 1999; Ulvund & Smith, 1996; Yoder, Warren, & McCathren, 1998).

The act of engaging in object-based attention with others is fundamentally an interpersonal process, embedded within a social context. Trevarthen and Hubley (1978) argued that the ability to engage in triadic joint attention (where caregiver and infant both direct their attention to an object) is the "developmental heir" of earlier dyadic social exchanges (where caregiver directs attention to infant while infant directs attention to caregiver). Dyadic social attention is thought to promote the emergence of triadic joint attention as it offers a social context within which the caregiver can scaffold infant attention (Bakeman & Adamson, 1984). Despite these assumptions about the social origins of shared attention, research has tended to focus exclusively on active, object-focused joint attention. For example, one of the most well established and widely used assessments of joint attention, the Early Social Communication Scales (ESCS: Mundy et al., 2003; Seibert, Hogan, & Mundy, 1982), assesses only object-focused joint attention, distinguishing between infants' tendency to respond to an experimenter's bid

for joint attention and infants' own initiations of joint attention, either for the purpose of social sharing or to help them achieve a goal such a reaching a toy.

In order to explore how these active forms of joint attention relate to more passive ways in which infants can share attention with another person, Gaffan, Martins, Healy, and Murray (2010) defined *parallel attention* as interaction where both infant's and caregiver's attention is focused on the same object, but the infant displays no explicit recognition that he/she is sharing attention with a social partner. Gaffan et al. (2010) reported that time spent in parallel attention with the mother at 6 months was positively related to active, object-based joint attention with an experimenter (where the infant checked the experimenter's gaze to ensure joint attention) at 9 months. However, Gaffan et al.'s study did not include any measure of infants' responses to bids for joint attention, so it was not possible to investigate interrelations between parallel attention, responses to joint attention bids, and infants' active initiations of joint attention. Addressing this issue was the first aim of the present study.

Two major theoretical models of joint attention currently exist: a model emphasizing the social-cognitive nature of joint attention (Tomasello, 1995; Tomasello, Carpenter, Call, Behne, & Moll, 2005), and the multiple process model (Mundy, Card, & Fox, 2000). The former proposes that infants' understanding of intentions underpins their ability to share attention with other people. According to this account, measures of different joint attention behaviors (e.g., responding and initiating) should be positively correlated. This model has received support from studies showing that social cognition is a common source of variance for distinct joint attention skills (Brooks & Meltzoff, 2005; Carpenter et al., 1998). In contrast, the multiple process model advocates that manifold executive and social motivation processes influence joint attention abilities and later social-cognitive development (Mundy et al., 2007). According to this model,

there should be no intercorrelations between different measures of joint attention, and each should be associated with a specific set of explanatory variables. This model has also received empirical support (Mundy et al., 2007; Vaughan et al., 2003), including research describing different patterns of brain activity associated with different types of joint attention (Caplan et al., 1993; Henderson, Yoder, Yale, & McDuffie, 2002). A second aim of the present study was to investigate whether responding to joint attention behaviors and initiating joint attention behaviors were intercorrelated.

Our final aim was to explore potential correlates of infants' attention abilities. While a good deal of previous research has investigated relations between joint attention and early cognitive development (e.g., Brooks & Meltzoff, 2005; Morales, Mundy, Crowson, Neal, & Delgado, 1998; Mundy et al., 2007; Mundy, Sigman, & Kasari, 2008; Tomasello & Farrar, 1986), the social-emotional correlates of attention abilities have been comparatively neglected. The few studies in this area have investigated how various aspects of infant–mother interactive behavior relate to infants' tendency to share attention with a social partner. Vaughan et al. (2003) reported that appropriate caregiver scaffolding in toy-play at 9 months was positively associated with infant joint attention with an experimenter at 12 months. More specifically, Gaffan et al. (2010) found that maternal teaching behaviors (e.g., pointing or demonstrating) at 6 months predicted active joint attention with the mother at 9 months. In contrast, infants' tendency to initiate joint attention with the mother at 9 months was negatively related to mothers' concurrent entertaining behaviors (e.g., animating a toy or teasing).

A second line of evidence suggests a link between infant joint attention and measures of more general patterns of infant–mother interaction. Infants' triadic communication has been found to be positively associated with maternal sensitivity (Hobson, Patrick, Crandell, Perez, & Lee, 2004) and responsiveness (Landry, Smith, &

Swank, 2006). A recent study by Meins et al. (2011) investigated relations between infant–mother attachment security and infants' previous (age 8 months) and concurrent (age 15 months) joint attention abilities. Meins et al. reported security-related differences specifically in infants' initiations of joint attention both with an experimenter and the mother. Infants with insecure-avoidant attachments to their mothers initiated more joint attention with an experimenter and less joint attention with their mothers than their counterparts in the secure and insecure-resistant attachment groups, but these differences were apparent only at the later age when the attachment relationship was fully formed. Meins et al. concluded that individual differences in the attachment relationship with the mother influenced infants' active engagement with social partners, and suggested that insecure-avoidant infants' heightened tendency to initiate joint attention with a new social partner might be a strategy to compensate for their avoidance of social contact with the mother.

The adaptive value of the infants' emergent ability to regulate negative emotionality may play an important role in their nascent joint attention skills. In particular, positive links between infants' joint attention and their ability to regulate negative emotions have been reported (Morales et al., 2005; Raver, 1996), underscoring how attentional mechanisms can contribute to the regulation of distress. However, it is also conceivable that infants' negative emotionality interferes with their ability to explore the environment (Kopp, 1989), therefore hindering their engagement in parallel and joint attention. High expression of negative emotionality may be considered a result of less optimal emotion regulation strategies (Raver, 1996), which may in turn diminish the infant's opportunities to engage in parallel and joint attention. Indeed, some have suggested that emotional mechanisms are involved in the ability to detect direction of gaze and occurrence of eye contact (Adolphs, 2001; Baron-Cohen et al., 2000;

Kawashima et al., 1999). Thus, it may be the case that negative emotionality is a cause rather than an effect of diminished joint attention.

The evidence from these previous studies converges to suggest that mothers who are better able to adapt their behavior to their infants' attentional rhythms may promote infant parallel and joint attention by providing the necessary structure to the infants' developing attention skills, as well as highlighting the potential role of certain infant-centered characteristics in the development of joint attention. In order to explore the relation between maternal interactive behavior, infant negative emotionality, and infant joint attention in more detail, the study reported here included a measure of emotional availability, and focused on the period in the first year of life when infants' joint attention abilities begin to emerge. Emotional availability (Easterbrooks & Biringen, 2005) is defined in terms of the ability to express a range of positive and negative emotions as well as to attune and respond to the partner's emotions. We chose emotional availability as an index of quality of interaction because it indexes both infant and mother behaviors. We hypothesized that better relationship quality, reflected by more emotional availability, would relate to higher levels of parallel and joint attention.

In summary, several hypotheses were examined in this study. Firstly, we expected (a) positive associations to emerge between parallel attention and both indices of joint attention (responding and initiating). Additionally, we investigated interrelations among responding and initiating joint attention, but did not test any specific directional hypothesis. We also hypothesized that (b) better relationship quality, reflected by more emotional availability, would relate to higher levels of parallel and joint attention. Moreover, we expected maternal entertaining, teaching, and attention-directing behaviors to play distinct roles in the prediction of parallel and joint attention abilities. With respect to the relation between infant negative emotionality and joint attention

behaviors, if negative emotionality plays a causal role in children's joint attention abilities, early in development one would expect high expression of negative emotionality to relate to lower levels of parallel and joint attention. However, if the opposite direction of cause and effect obtains, infant negative emotionality and attention behaviors might be unrelated. We therefore investigated the relation between negative emotionality and attention abilities, but did not test any directional hypothesis.

Method

Participants

Participants were 52 mother–infant dyads (31 boys, 59.6%) recruited from childcare centers in a large city in the north of Portugal who were participating in a study on child development. Infants were aged 9 to 11 months (M = 10.38, SD = 0.36). All infants had 5 min APGAR scores ≥ 8, none was diagnosed with a developmental disability, and the mean gestation period was 38.1 weeks (SD = 1.68). Mothers were aged 24 to 45 years (M = 33.45, SD = 4.76), married or cohabiting. Concerning maternal education, the majority (65.4%; n = 34) had higher education qualifications, while the remaining 34.6% (n = 18) had completed between 5 and 12 years of formal education. All participants were White and had Portuguese as their first language.

Procedure

The 52 dyads were visited in their homes when infants were aged around 10 months. During this visit, mother–infant interactions were video recorded. About two weeks after the home visit, a visit to the infant's childcare center was scheduled and their developmental level was assessed.

The home-based observations had an approximate duration of 40 minutes. In the first 20 minutes, mothers were asked to behave as naturally as possible so that she and the baby became comfortable with the presence of the researcher. Mothers were then

asked to play with their infants as they normally would with the baby's favorite toys, allowing for a 10-minute toy-play session to be recorded. Following this period of play, mothers were requested to teach their infants how to play with a shape sorter. This task lasted 10 minutes and the toy was considered to be above the infant's current developmental level.

Parallel and Joint Attention Behaviors.

The 10-minute toy-play interaction was coded using an adaptation of the joint attention scheme designed by Martins (2003). We opted to code the unstructured toy play session as it provided a more naturalistic context for joint attention behaviors to occur. This coding scheme was especially developed for the microanalytic assessment of joint attention in mother–infant play sessions. The infant's face was clearly visible at all times so that infants' focus of attention could be assessed. The occurrence of efforts to draw the partner's attention to a target (usually a toy) and the infant's responses to maternal bids for joint attention were the focus of the coding and included the following behaviors:

a) **Mother's bids for joint attention.**

The frequency of seven behaviors was coded: *engaging with contact* (playfully touching the infant with the toy); *animating a toy* (expressive performances to entertain the infant - e.g., rattling or moving the toy); *showing a toy* to the infant; *offering* the toy, *pointing* (index finger extended towards a target); *demonstrating an action* (modeling specific actions for the infant to perform); and *verbal directives* (verbally encouraging the infant to direct the attention towards a target using directives, prompt questions/suggestions or even questions about the location of the toy). Summary scores were created from these behaviors to reflect three main functions: *Mother entertains*, which comprised engaging with contact and animating behaviors; *Mother teaches*,

which involved pointing and demonstrating; and *Mother directs attention*, which incorporated showing and offering a toy, as well as verbal directives. Mothers received a frequency score for each of these three behaviors. We also computed a total score which incorporated the total number of maternal bids for joint attention.

b) **Infant's response to maternal bids for joint attention.**

Immediately after the occurrence of any of the maternal behaviors presented above, the infant's response received one of three possible codings: *Achieves parallel attention* (in accordance with Gaffan et al. (2010), by following the mother's action on the toy, but never alternating gaze between mother and toy); *Responds to joint attention* (by following the mother's line of gaze and action on the toy, and alternating gaze between mother and toy); *Ignores* (if the infant did not show any signs of being involved with the toy, attested by the fact that he/she did not look at the mother's action). Parallel attention and responding to joint attention were subsequently scored as the proportion of instances of involvement in parallel attention and in joint attention (respectively), divided by the total number of maternal bids.

c) **Infant initiating joint attention.**

Initiating joint attention was defined as one of three behaviors. With the exception of non-communicative pointing, all required the infant to look at the mother while performing the following actions: *animating a toy* (moving the toy with the purpose of getting the mother's attention); *offering a toy* (holding out a toy to the mother); *pointing* (extending the index finger in a conventional manner). Pointing could be of communicative nature (if the infant looked at the mother's face at some point before, during or after the gesture) or non-communicative nature (if the infant did not look at the mother's face at any time). Infants received a frequency score for each type of behavior. However, due to the low frequency of initiating behaviors and in common

with other research groups (e.g., Gaffan et al., 2010; Vaughan et al., 2003) we decided to collapse them into a single overall score.

All the videotapes were independently coded by two trained judges. Cohen's kappa was adequate across all categories (Mother engages with contact = .75; Mother animates toy = .70; Mother shows = .72; Mother offers = .71; Mother points = .71; Mother demonstrates = .71; Mother gives verbal directives = .71; Infant parallel attention = .73; Infant responding to joint attention = .79; Infant initiating joint attention = .73).

Emotional availability.

The first 30 minutes of filming (20 minutes of free interaction and the following 10 minutes of toy-play interaction) were coded using the *Emotional Availability Scales – 3rd edition* (Biringen, Robinson, & Emde, 1998). This coding system allows for the assessment of emotional availability based on both maternal and infant behaviors. The maternal scales are: *Sensitivity* (9-point scale indicating maternal characteristics of warmth and emotional connectedness as well as appropriate and contingent responsiveness to infant's signals); *Structuring* (5-point scale reflecting the mother's ability to appropriately scaffold the infant's play, taking into consideration his/her abilities); *Non-intrusiveness* (5-point scale that describes the mother's ability to be available for the infant, without being intrusive or controlling); *Non-hostility* (5-point scale reflecting the absence of any implicit or explicit signs of hostility or impatience towards the infant). The infant scales are comprised of: *Child Responsiveness* (7-point scale indicating the infant's willingness and pleasure in responding to the mother's bids); and *Child Involvement* (7-point scale reflecting the infant's ability to invite the mother into play, while maintaining a good balance between autonomous exploration and involvement of the mother). The summing of the scales for both infant and mother

behaviors yielded a total emotional availability score, with higher scores indicating more emotional availability. Previous work by the scale's first author supports the use of the total score (Wiefel et al., 2005).

All interactions were scored independently by four trained judges. For reliability purposes, 48% of the videotapes were randomly selected and distributed to pairs of raters for double coding. Intraclass correlation coefficients were calculated for each of the mother and infant dimensions and revealed adequate interrater reliability (Sensitivity, r_i = .88, Structuring, r_i = .92; Non-intrusiveness, r_i = .77, Non-hostility, r_i = .86; Responsiveness, r_i = .85, Involvement, r_i = .80).

Infant's expression of negative emotionality.

In the final 10-minute session the dyads were presented with a shape sorter and mothers were asked to teach their infants to place the shapes in the correct holes. Because this task was long and developmentally challenging, negative emotionality was expected to emerge. Infants' behaviors (e.g., back arching) and vocalizations (e.g., fussing, crying) indexed their level of distress. Infants were classified into one of eight categories of negative emotionality (Martins, 2007; Martins & Soares, 2008): 8 – No expression of negative emotionality; 7 – Rare expression of negative emotionality (throughout the task, the infant rarely shows signs of being distressed); 5 – Some expression of negative emotionality (the infant becomes distressed at times, however he/she is still able resume neutral or positive emotionality); 3 – Frequent expression of negative emotionality (the infant spends most of the time displaying distress); 1 – Predominance of negative emotionality (throughout the 10-minute session, the infant is almost persistently distressed). The remaining categories of 2, 4, and 6 reflect situations in which infants' behaviors throughout the session are placed between two adjacent categories.

All interactions were independently scored by four trained judges. For reliability purposes, 67% of the videotapes were randomly selected and distributed to pairs of raters for double coding. Intraclass correlation coefficient was .96 across the sampled interactions.

Infant mental development.

The infants' mental development was assessed approximately two weeks after the home visit using the *Bayley Scales of Infant Development* (BSID-II; Bayley, 1993). The BSID-II were administered in the childcare center by trained researchers, yielding a mental development index (MDI). The BSID-II have been shown to have good reliability (.83 for the mental scales).

Results

Descriptive Statistics and Preliminary Analyses

The descriptive statistics for maternal and infant measures are presented in Table 1. All but one of the mothers (98.1%) showed at least one behavior pertaining to the dimensions Mother entertains and Mother directs attention. Thirty-seven (71.2%) mothers showed at least one behavior in the Mother teaches category.

Regarding infant attention variables, one (1.9%) showed no instances of parallel attention, thirteen (25%) infants showed no responding to joint attention behaviors, and 15 infants (28.8%) displayed no initiating joint attention behaviors. Seven infants from the sample (13.5%) showed no responding to or initiating joint attention behaviors. Infants' responding to joint attention and initiating joint attention were positively skewed, and were thus transformed into dichotomous variables. Nevertheless, infants could still be distinguished in two groups: one group displaying no initiating behaviors (scored 0), and another group displaying at least one form of initiating joint attention (scored 1). The same principle was applied to responding to joint attention. Each infant

was classified into one of two categories: 0 if s/he showed no attention responding behaviors; 1 if the infant showed one or more such behaviors.

Additionally, the data on negative emotionality suggest that this variable was negatively skewed. Therefore, we grouped together infants who were coded from 1 to 5 and assigned them the score of 1 – high expression of negative emotionality; whereas infants coded from 6 to 8 were assigned the score of 0 – low expression of negative emotionality.

Relations Between Parallel Attention, Responding to Joint Attention and Initiating Joint Attention

Parallel attention was marginally correlated with infant responding to joint attention, $r_{pb}(50) = .26$, $p = .064$, with a medium size effect (Cohen, 1988) for this relation, but parallel attention was unrelated to infant initiating joint attention, $r_{pb}(50) = .15$, $p = .277$. Responding to and initiating joint attention were positively associated using both the frequency, $\rho(50) = .37$, $p = .007$, and the dichotomous, $\chi^2(1) = 5.28$, $p = .022$, measures.

Relations Between Infant Attention, Maternal Bids and Control Variables

Association tests were performed between infant parallel attention, joint attention (responding to joint attention and initiating joint attention) and maternal bids for joint attention and the following control variables: infant age and sex, and maternal education. No significant associations emerged, except for a marginally significant association between infant initiating joint attention and infant gender. $\chi^2(1) = 3.64$, $p = .056$.

Relations Between Infant Attention Indices and Maternal Bids

Table 2 presents the correlations involving the dependent variables (infant parallel attention, responding to joint attention, and initiating joint attention) and the different categories of maternal bids for joint attention.

Parallel attention was positively correlated with maternal entertaining behaviors and total maternal bids. Responding to joint attention was associated with total maternal bids for joint attention, as higher frequency of maternal behaviors intended to draw the infant's attention was related to the occurrence of infant responding. The presence of infant responding behaviors was also marginally associated with two types of maternal bids for joint attention – Mother entertains, and Mother directs attention, but not Mother teaches. Initiating joint attention was negatively correlated with Mother teaches category, as higher frequency of maternal teaching behaviors was associated with the absence of infant initiating joint attention.

Next, we performed hierarchical regression analyses in order to examine which variables were unique predictors of each of the attention indices.

Regression Analyses

Hierarchical regression models were performed for each infant attention variable based on theoretical principles as well as on the significant associations previously described with maternal bids for joint attention. All three regression models had the same basic structure. At step 1, Bayley MDI was entered as a control variable, followed at step 2 by infant negative emotionality. At step 3, emotional availability was entered. Finally, at step 4, the specific category of maternal bids for joint attention that was significantly correlated with the attention variable was entered.

Parallel attention.

Two variables regarding maternal bids for joint attention were correlated with parallel attention: maternal entertaining strategies and total maternal bids for joint

attention (see Table 2). However, the variable concerning total maternal bids was not incorporated in the regression model in order to prevent singularity. We opted to include only the specific maternal strategy (Mother entertains) rather than the more global score.

As shown in Table 3, with all variables entered into the regression equation, Bayley MDI, infants' negative emotionality, and Mother entertains each predicted unique variance in infants' parallel attention. Infant engagement in parallel attention was positively associated with infants' general cognitive ability as assessed on the Bayley MDI and mothers' entertaining behaviors, and negatively associated with infants' negative emotionality.

Responding to joint attention.

Total maternal bids for joint attention was the maternal variable correlated with responding to joint attention (see Table 2) and was entered into the regression equation at the final step. As shown in Table 4, with all variables entered into the regression equation, total maternal bids for joint attention was a marginally significant predictor of infants' responding to joint attention.

Initiating joint attention.

Mother teaches was the maternal variable correlated with initiating joint attention (see Table 2) and was entered into the regression equation at the final step. As shown in Table 5, with all variables entered into the regression equation, infant negative emotionality predicted unique variance in initiating joint attention, with a marginally significant effect of Mother teaches. Initiating joint attention was negatively related to infant negative emotionality and maternal teaching behaviors.

Discussion

Previous studies have focused on the patterns of emergence and correlates of joint attention. However, very few included measures of parallel attention, an index of infant attention thought to precede joint attention (Bakeman & Adamson, 1984; Gaffan et al., 2010). Our results show a positive marginal association between parallel attention and responding to joint attention, indicating a medium effect size for this relation. This result is consistent with Bakeman and Adamson's (1984) suggestion that parallel attention is an implicit social context that scaffolds the emergence of more active infant joint attention. We believe this may be the case because parallel attention and responding to (but not initiating) joint attention both entail that the infant attends to or follows the focus of attention presented by the social partner. Conversely, parallel attention did not correlate with infant initiating behaviors, suggesting that the former might be involved in the development of the response dimension of joint attention, but not in initiating behaviors. Furthermore, responding to and initiating joint attention were found to be positively associated. This last result is relevant to the discussion of whether different measures of joint attention reflect common (e.g., Tomasello, 1995) or multiple sources of variance (e.g., Mundy et al., 2000). The positive association between responding to and initiating joint attention in our study is in line with the notion that both indices of joint attention can be considered, at least partially, to be expressions of a common ability to understand intentionality in others (Tomasello, 1995). That said, our results showed that responding to joint attention and initiating joint attention were each predicted by a distinct set of variables, suggesting that these two forms of object-based joint attention have different social correlates.

With respect to the correlates of the attention indices studied, we found consistent associations between infant attention and maternal bids for joint attention. However, different specific maternal behaviors were related to different types of infant

attention. Parallel attention was related to maternal entertaining behaviors, with infants engaging in more parallel attention if their mothers were more likely to interact with their infants in an entertaining, playful manner. Infants' responses to joint attention were positively related to mothers' overall amount of attention-eliciting behavior. In contrast, there was a negative association between infants' initiations of joint attention and mothers' engagement in teaching behaviors, suggesting that infants are less likely to take the initiative in establishing joint attention if their mothers tend to adopt a didactic approach to the interaction, rather than involving the child as a more active participant in her bids for joint attention. This confirms and expands previous research (e.g. Gaffan et al., 2010; Vaughan et al., 2003), further clarifying the relation between specific maternal behaviors and individual differences observed in infant parallel and joint attention.

The results of the regression analyses also highlighted the fact that the three measures of infant attention were each related to different variables. Mothers' entertaining behaviors predicted unique variance in parallel attention, but maternal bids for attention were only marginally significant in predicting infants' responses to or initiations of joint attention. For response to joint attention, the regression failed to identify any independent predictors. It is conceivable that antecedent, rather than concurrent predictors might have had a stronger impact on this aspect of infant joint attention. Results by Gaffan et al. (2010) support such claim, as they found 9-month shared attention with the mother was predicted by 6-month, but not 9-month measures.

Another key finding of this study resides in the fact that infant expression of negative emotionality predicted independent variance in both parallel attention and initiating joint attention. Both of these indices of attention were negatively associated with infants' expression of negative emotionality during a cognitively challenging task.

Previous studies have found associations between infants' ability to engage in joint attention and subsequent emotion regulation strategies (Morales et al., 2005; Raver, 1996). Our study extends these findings by showing an association between concurrent expression of negative emotionality and parallel and initiating joint attention. Although we cannot make strong claims regarding direction of causality, our results seem to support the notion that negative emotionality may influence children's attention abilities. In fact, relevant neurophysiological findings have shown emotional mechanisms to be involved in joint attention related skills such as gaze monitoring (Kawashima et al., 1999). From this perspective, high negative emotionality may disturb behavioral organization, thus hindering infants' ability to mobilize their joint attention skills. Because later developing initiating behaviors are thought to pose more attentional demands on the infant than early developing responding to joint attention (Mundy & Newell, 2007), it is conceivable that the expression of negative emotionality had a particularly significant impact in the infant's nascent abilities to intentionally direct other's direction of gaze towards a new focus. In contrast, we believe that the influence of negative emotionality may have operated differently for parallel attention. On the one hand, this is a relatively mature skill which is believed to emerge around three months earlier than joint attention. In addition, due to the demands of the task, compliance may be a dimension underlying parallel attention. Indeed, research has found links between infant compliance to mother, and infants' mental development (Lieberman, Padan-Belkin, & Harel, 1995) and expression of negative emotionality (Stifter, Spinrad, & Braungart-Rieker, 1999). Nevertheless, parallel attention is a relatively unexplored index of infant attention, so more studies are needed in order to further clarify its nature and core mechanisms.

Contrary to our initial hypothesis, emotional availability did not make a unique contribution to parallel or joint attention. These results are surprising as we expected mother–infant relationship quality to have an impact on infant's ability and willingness to share attention and emotions. One reason for the null findings may be the young age of the infants who participated in our study. For example, Meins et al. (2011) reported that a relation between infant–mother attachment security and infant joint attention was detected only once the attachment relationship had been consolidated. Thus, at ages when the attachment relationship is still in the process of being formed, mothers' specific behaviors in attracting their infants' attention, rather than the global quality of the infant–mother relationship, appear to relate to infants' tendency to engage in shared attention.

Our study offers a comprehensive approach to the understanding of the factors accounting for differences in infant parallel and joint attention at 10 months. We did so by including measures of maternal behavior, as well as relationship quality, and infant characteristics. We were able to discern the impact of different categories of maternal bids for joint attention - entertaining, teaching, and attention-directing behaviors - to parallel attention, as well as responding to joint attention and initiating joint attention. In addition, results highlight infants' expression of negative emotionality as an important predictor of these attention indices in the first year of life.

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References

Adamson, L. B., Bakeman, R., & Deckner, D. F. (2004). The development of symbol-infused joint engagement. *Child Development*, *75*(4), 1171–1187.

Adolphs, R. (2001). The neurobiology of social cognition. *Current Opinion in Neurobiology*, *11*(2), 231–239.

Bakeman, R., & Adamson, L. B. (1984). Coordinating attention to people and objects in mother-infant and peer-infant interaction. *Child Development*, *55*, 1278-1289.

Baron-Cohen, S., Ring, H. A., Bullmore, E. T., Wheelwright, S., Ashwin, C., & Williams, S. C. R. (2000). The amygdala theory of autism. *Neuroscience & Biobehavioral Reviews*, *24*(3), 355–364.

Bayley, N. (1993). *Bayley Scales of Infant Development: Manual* (2nd ed.). USA: The Psychological Corporation.

Biringen, Z., Robinson, J. L., & Emde, R. N. (1998). *The Emotional Availability Scales* (3rd ed.). Unpublished manual, Colorado State University.

Brooks, R., & Meltzoff, A. (2005). The development of gaze following and its relation to language. *Developmental Science*, *8*(6), 535-543.

Caplan, R., Chugani, H., Messa, C., Guthrie, D., Sigman, M., Traversay, J., … Mundy, P. (1993). Hemispherectomy for early onset intractable seizures: Presurgical cerebral glucose metabolism and postsurgical nonverbal communication patterns. *Developmental Medicine and Child Neurology, 35*(7), 574-581

Carpenter, M., Nagell, K., & Tomasello, M. (1998). Social cognition, joint attention, and communicative competence from 9 to 15 months of age. *Monographs of the Society for Research in Child Development*, *63*(4), i+iii+v-vi+1-174.

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences*. Hillsdale, NJ: Erlbaum.

Dawson, G., Toth, K., Abbott, R., Osterling, J., Munson, J., Estes, A., & Liaw, J. (2004). Early social attention impairments in autism: Social orienting, joint attention, and attention to distress. *Developmental Psychology*, *40*(2), 271–283.

Delgado, C. E., Mundy, P., Crowson, M., Markus, J., Yale, M., & Schwartz, H. (2002). Responding to joint attention and language development: A comparison of target locations. *Journal of Speech, Language, and Hearing Research*, *45*(4), 715.

Easterbrooks, M., & Biringen, Z. (2005). The Emotional Availability Scales: Methodological refinements of the construct and clinical implications related to gender and at-risk interactions. *Infant Mental Health Journal*, *26*(4), 291–294.

Gaffan, E. A., Martins, C., Healy, S., & Murray, L. (2010). Early social experience and individual differences in infants' joint attention. *Social Development*, *19*(2), 369-393.

Henderson, L. M., Yoder, P. J., Yale, M. E., & McDuffie, A. (2002). Getting the point: electrophysiological correlates of protodeclarative pointing. *International Journal of Developmental Neuroscience*, *20*, 449–458.

Hobson, R. P., Patrick, M. P., Crandell, L. E., Perez, R. M. G., & Lee, A. (2004). Maternal sensitivity and infant triadic communication. *Journal of Child Psychology and Psychiatry*, *45*(3), 470–480.

Kawashima, R., Sugiura, M., Kato, T., Nakamura, A., Hatano, K., Ito, K., Fukuda, H., … Nakamura, K. (1999). The human amygdala plays an important role in gaze monitoring: A PET study. *Brain*, *122*(4), 779-783. doi:10.1093/brain/122.4.779.

Kopp, C. B. (1989). Regulation of distress and negative emotions: A developmental view. *Developmental Psychology*, *25*(3), 343–354.

Landry, S. H., Smith, K. E., & Swank, P. R. (2006). Responsive parenting: Establishing early foundations for social, communication, and independent problem-solving

skills. *Developmental Psychology*, *42*(4), 627–641.

Lieberman, D., Padan-Belkin, E., & Harel, S. (1995). Maternal directiveness and infant compliance at one year of age: A comparison between mothers and their developmentally-delayed infants and mothers and their non-delayed infants. *Journal of Child Psychology and Psychiatry*, *36*(6), 1091–1096.

Martins, C. (2003). *The emergence of secondary intersubjectivity: Predictors and sequelae in infants of well and depressed mothers* (Unpublished doctoral dissertation, University of Reading, Reading, United Kingdom).

Martins, E. C. (2007). *Regulação emocional diádica, temperamento e nível de desenvolvimento aos 10 meses como preditores da qualidade da vinculação aos 12/16 meses* [Dyadic emotion regulation, temperament and developmental level at 10 months as predictors of attachment quality at 12/16 months.] (Unpublished doctoral dissertation, University of Minho, Braga, Portugal).

Martins, E. C., & Soares, I. (2008). Dyadic emotion regulation and temperament at 10 months as predictors of attachment quality at 12/16 months. *Infant Mental Health Journal, 29*(3A), No. 389.

McCune, L. (1995). A normative study of representational play in the transition to language. *Developmental Psychology*, *31*(2), 198–206.

Meins, E., Leekam, S. R., Fernyhough, C., Arnott, B., Vittorini, L., Parkinson, K., & Turner, M. (2011). Individual differences in infants' joint attention behaviors with mother and a new social partner. *Infancy*, DOI: 10.1111/j.1532-7078.2010.00065.x.

Morales, M., Mundy, P., Crowson, M. M., Neal, A. R., & Delgado, C. E. F. (2005). Individual differences in infant attention skills, joint attention, and emotion regulation behaviour. *International Journal of Behavioral Development*, *29*(3),

259-263. doi:10.1177/01650250444000432.

Morales, M., Mundy, P., & Rojas, J. (1998). Following the direction of gaze and language development in 6-month-olds. *Infant Behavior and Development*, *21*(2), 373–377.

Mundy, P., Block, J., Delgado, C., Pomares, Y., Van Hecke, A. V., & Parlade, M. V. (2007). Individual differences and the development of joint attention in infancy. *Child Development*, *78*(3), 938 – 954.

Mundy, P., Card, J., & Fox, N. (2000). EEG correlates of the development of infant joint attention skills. *Developmental Psychobiology*, *36*, 325–338.

Mundy, P., Delgado, C., Block, J., Venezia, M., Hogan, A., & Seibert, J. (2003). A manual for the Abridged Early Social Communication Scales (ESCS). Retrieved from http://www.ucdmc.ucdavis.edu/mindinstitute/ourteam/faculty_staff/ESCS.pdf.

Mundy, P., & Neal, R. (2001). Neural plasticity, joint attention, and a transactional social-orienting model of autism. *International Review of Research in Mental Retardation*, *23*, 139–168.

Mundy, P., & Newell, L. (2007). Attention, joint attention, and social cognition. *Current directions in psychological science*, *16*(5), 269-274.

Mundy, P., Sigman M., & Kasari, C. (2008). Joint attention, developmental level, and symptom presentation in autism. *Development and Psychopathology, 6*(3), 389-401.

Raver, C. C. (1996). Relations between social contingency in mother-child interaction and 2-year-olds' social competence. *Developmental Psychology*, *32*(5), 850-859. doi:10.1037/0012-1649.32.5.850.

Seibert, J. M., Hogan, A. E., & Mundy, P. C. (1982). Assessing interactional

competencies: The early social-communication scales. *Infant Mental Health Journal*, *3*(4), 244-258. doi:10.1002/1097-0355(198224)3:4<244::AID-IMHJ2280030406>3.0.CO;2-R.

Sigman, M., & Ruskin, E. (1999). Continuity and change in the social competence of children with autism, Down syndrome, and developmental delay. *Monographs of the Society for Research in Child Development*, *64*(Serial No. 256), 1-108.

Stifter, C. A., Spinrad, T., & Braungart-Rieker, J. (1999). Toward a developmental model of child compliance: The role of emotion regulation in infancy. *Child Development*, *70*(1), 21–32.

Tomasello, M. (1995). Joint attention as social cognition. In C. Moore & P. Dunham (Eds.), *Joint attention: Its origins and role in development* (pp. 103-130). Hillsdale, NJ: Erlbaum.

Tomasello, M., Carpenter, M., Call, J., Behne, T., & Moll, H. (2005). Understanding and sharing intentions: The origins of cultural cognition. *Behavioral and Brain Sciences*, *25*, 675–735.

Tomasello, M., & Farrar, M. J. (1986). Joint attention and early language. *Child Development, 57*(6), 1454-1463.

Trevarthen, C., & Hubley, P. (1978). Secondary intersubjectivity: Confidence, confiding and acts of meaning in the first year. In A. Lock (Ed.), *Action gesture and symbol* (pp. 183-229). London: Academic Press.

Ulvund, S. E., & Smith, L. (1996). The predictive validity of nonverbal communicative skills in infants with perinatal hazards. *Infant Behavior and Development*, *19*(4), 441–449.

Vaughan, A., Mundy, P., Block, J., Burnette, C., Delgado, C., Gomez, Y., … Pomares, Y. (2003). Child, caregiver, and temperament contributions to infant joint

attention. *Infancy*, *4*(4), 603 – 616.

Wiefel, A., Wollenweber, S., Oepen, G., Lenz, K., Lehmkuhl, U., & Biringen, Z. (2005). Emotional availability in infant psychiatry. *Infant Mental Health Journal 26*(4), 392 – 403.

Yoder, P. J., Warren, S. F., & McCathren, R. B. (1998). Determining spoken language prognosis in children with developmental disabilities. *American Journal of Speech-Language Pathology*, *7*(4), 77.

Table 1

Mother and Infant Measures

	Min-Max	Mean	(SD)	Median
Mother				
Bids for joint attention				
Mother entertains	0-172	47.98	32.74	46.00
Mother teaches	0-38	6.40	8.28	4.00
Mother directs attention	0-74	27.35	16.97	25.00
Infant				
Response to maternal bids for joint attention				
Parallel attention (proportion)	0-.96	.68	.19	.72
Responding to joint attention (proportion)	0-.21	.05	.05	.05
Initiating joint attention	0-14	2.65	2.97	2.00
Negative emotionality	3-8	6.12	1.63	7.00
Bayley MDI	69-120	95.16	12.79	96.00

Note. One infant attained MDI < 70. Since the pattern of results remained unchanged when this case was filtered, we present the results including the entire sample.

Table 2

Correlations Between Infants' Attention and Maternal Bids for Joint Attention

	Parallel attention	Joint attention	
		Responding	Initiating
Maternal bids for joint attention			
Mother entertains	[a].34*	[b].25[+]	[b]-.18
Mother teaches	[a]-.03	[b].01	[b]-.36**
Mother directs attention	[a].07	[b].24[+]	[b].003
Total maternal bids for joint attention	[a].30*	[b].30*	[b]-.22

Note. [a] r; [b] r_{pb}

[+] $p < .10$; * $p < .05$; ** $p < .01$

Table 3

Regression Model for Infant Parallel Attention

Steps and variables	R^2	(Adjusted R^2)	β	*F* change
Step 1 (df 1,49)	.07	(.05)		3.75^{+}
Bayley MDI			$.27^{+}$	
Step 2 (df 2,48)	.18	(.15)		6.47*
Bayley MDI			.26*	
Negative emotionality			-.33*	
Step 3 (df 3,47)	.25	(.20)		3.93^{+}
Bayley MDI			.26*	
Negative emotionality			-.30*	
Emotional availability			$.25^{+}$	
Step 4 (df 4,46)	.32	(.26)		5.21*
Bayley MDI			.29*	
Negative emotionality			-.27*	
Emotional availability			.18	
Mother entertains			.29*	

$^{+}p < .10$; * $p < .05$

Table 4

Binary Logistic Regression Model for Infant Responding to Joint Attention

			95% CI for Odds Ratio		
Steps and variables	χ^2	B(SE)	Lower	Odds ratio	Upper
Step 1 (df 1)	1.51				
Bayley MDI		-.03(.03)	.92	.97	1.02
Step 2 (df 2)	3.88				
Bayley MDI		-.03(.03)	.92	.97	1.02
Negative emotionality		1.07(.69)	.75	2.90	11.26
Step 3 (df 3)	4.59				
Bayley MDI		-.03(.03)	.92	.97	1.02
Negative emotionality		1.00(.70)	.68	2.70	10.69
Emotional availability		.05(.06)	.93	1.05	1.19
Step 4 (df 4)	8.10^{+}				
Bayley MDI		-.03(.03)	.92	.97	1.02
Negative emotionality		.89(.74)	.58	2.45	10.39
Emotional availability		.01(.07)	.89	1.02	1.15
Total maternal bids for JA		$.02^{+}$(.01)	1.00	1.02	1.04

Note. Total R^2 = .22 (Nagelkerke)

$^{+}p < .10$

Table 5

Binary Logistic Regression Model for Infant Initiating Joint Attention

			95% CI for Odds Ratio		
Steps and variables	χ^2	B(SE)	Lower	Odds ratio	Upper
Step 1 (df 1)	.22				
Bayley MDI		.01(.02)	.96	1.01	1.06
Step 2 (df 2)	5.82^{+}				
Bayley MDI		.01(.03)	.96	1.01	1.07
Negative emotionality		1.56^{+}(.67)	1.28	9.81	17.65
Step 3 (df 3)	4.51^{+}				
Bayley MDI		.01(.03)	1.01	1.01	1.07
Negative emotionality		-1.69*(.70)	1.38	5.44	21.40
Emotional availability		-.07(.06)	.83	.94	1.06
Step 4 (df 4)	10.87*				
Bayley MDI		.01(.03)	1.01	1.01	1.07
Negative emotionality		-1.69*(.70)	1.38	5.44	21.40
Emotional availability		-.07(.06)	.83	.94	1.06
Mother teaches		$-.08^{+}$(.05)	.84	.92	1.01

Note. Total R^2 = .27 (Nagelkerke)

$^{+}$ $p < .10$; * $p < .05$